

# Internet Overlay Networks

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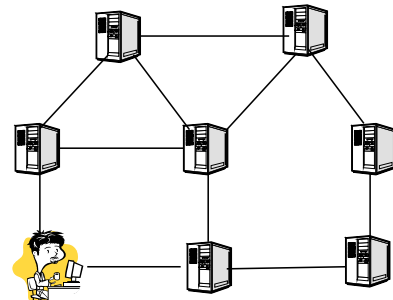
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1

## Overlay Networks

Overlay networks: A logical network laid on top of the Internet

- nodes are Internet end hosts
- links are virtual Internet paths



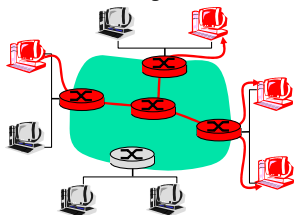
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2

## Multicast

- **Multicast**: act of sending data to multiple receivers.



Remember the protocols?

Practical problems of network-layer multicast:

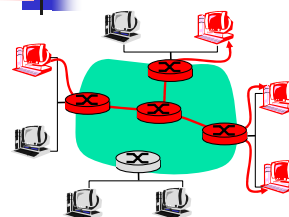
- requires routers to maintain per-group state; complicates the router design and implementation;
- slow to be widely adopted.

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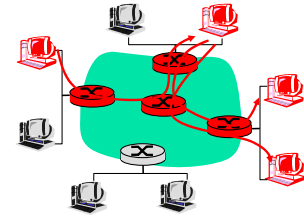
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3

## Network-layer vs. Overlay Multicast



Network-layer multicast



Overlay multicast

- performance issues for overlay multicast
  - Limit the bandwidth consumption of individual physical links
  - Minimize the source-to-end latency

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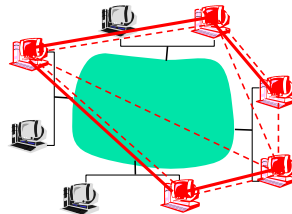
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4

## Overlay Multicast: One Approach

### Two steps:

- Forming an overlay mesh network with good links, don't worry about loops at this step
  - too dense a mesh results in too much overhead in the second step; more probable to have high link stress
  - too sparse a mesh restricts what the second step can do
- For each multicast source, generating a shortest path tree or "reverse-path forwarding" on top of the overlay mesh



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5

## Revisit the Concept of Overlay Networks

Overlay networks: A logical network laid on top of the Internet.

Key advantages over networks with physical links:

- can be formed spontaneously
- can be easily maintained and changed

Key disadvantage compared with networks with physical links:

- performance

Overlay networks = peer-to-peer networks?

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6

## Applications to Overlay Networks

- multicast: network conferencing
- peer-to-peer file sharing
- multi-player interactive games
- software/news/files distribution
- ... ..

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7

## Multiplayer Interactive Games over Wide-area Networks

### ■ Some basics:

- A virtual 2/3-dimensional gaming space with many objects
- Player-initiated actions: moving your objects, attacking some other objects, etc.

### ■ Main challenges:

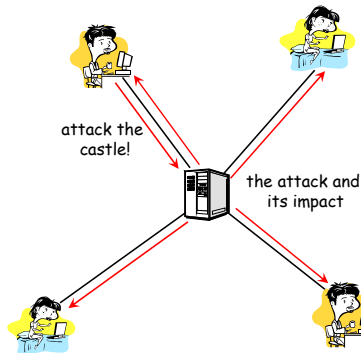
- **Scalability**: supporting many players
- **Interactive**: real-time constraint in synchronizing the actions and their impact on the gaming space
- **Wide-area network**: limited network resources

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8

## A straightforward way to do it



- a server and multiple client (each for a player)
- all player-initiated actions get to the server and its impact is propagated to all players (with bounded delay)
- actions can be aggregated when too many come too quickly

any other ideas about how it works?

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9

## Scalability

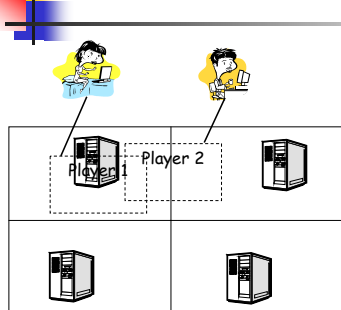
- What are the potential problems when the number of players scales up?
- Network bandwidth connecting the server is the main problem
- How to solve this?
  - multicast
  - distribute the server

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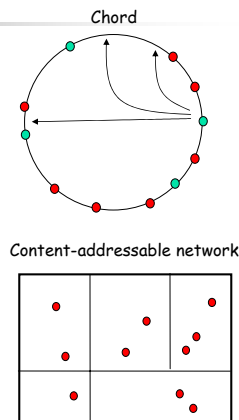
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10

## Distribute the Server



How do we keep track of which part belongs to which server?

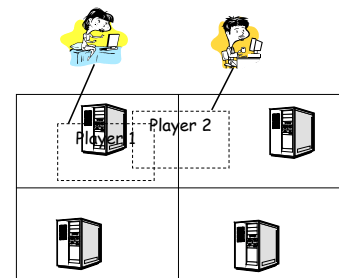


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11

## Distribute the Server (cont.)



Additional problems:

- load imbalance
- handoff between partitions is tricky

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12

## Files/News/Software Distribution on Demand

- Content distribution:
  - Popular web sites like Yahoo;
  - Breaking news from CNN;
  - Microsoft is distributing a new version of Windows online.
- All downloading from a central content site creates performance problems:
  - Limited bandwidth at the central site;
  - Many users are far away from the central site.

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13

## Means of Content Distribution

- By content providers, e.g., [www.yahoo.com](http://www.yahoo.com)
  - replicated, distributed Internet sites
- By content consumers (or clients), e.g., UR
  - reduce bandwidth consumption of an organization through caching - Web caching
- By a third-party
  - content distribution network

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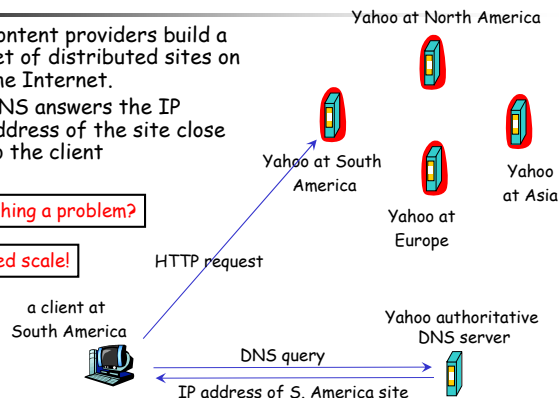
14

## Replicated Internet Sites

- Content providers build a set of distributed sites on the Internet.
- DNS answers the IP address of the site close to the client

Is DNS caching a problem?

limited scale!



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15

## Determining Nearby Content Server

- We create a "map", indicating distances between ISPs and content servers
- When a DNS query arrives at authoritative DNS server:
  - server determines ISP from which query originates
  - uses "map" to determine a nearby content server
- How to build the map?
  - pings from content servers to all possible ISPs

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16